tained in tornado prediction, but was due primarily to an injudicious system of predicting, and secondarily to an improper estimate of the nature of the problem. It would be impossible, of course, to say that such a tornado as that at Grinnell in 1882, and the recent one at Louisville, would occur in any district. All that we can do is to predict a disturbed region. In verification, it would hardly be fair to adopt principles which could be used in determining the skill of a marksman shooting at a target, for example; but we must take into account the knowledge we have already gained of the relative violence and the manner of occurrence of such storms. We must determine, on a scale, the number of violent storms occurring in any district where such storms were predicted, and not confine attention to the most violent alone. To draw an imaginary line, and say that if a storm occurs within five miles of that line, in a district where it was predicted, it shall count fully as a success, but if it occurs five miles on the other side of that line it shall count as a total failure, is to impose restrictions upon the problem which seem entirely unreasonable.

In a study of tornado predictions made by Mr. Finley for June, 1885, the present writer assumed "that violent storms occurring, in any district predicted for, half way between the centre and edge, shall have weight 1; in the rest of the district, $\frac{3}{4}$; to the centre of the next outlying district, $\frac{1}{2}$; to the edge of that district, $\frac{1}{4}$; all outside of these, 0" (see *American Journal of Science*, August, 1887, p. 129). The percentage of skill attained as thus measured was 49. Mr. Curtis, taking the same predictions and discussing them mathematically, found 14 per cent. Mr. Curtis has more recently (1887) adopted somewhat the method suggested above, and obtained 40 per cent. These percentages, however, mean very little as to showing a real knowledge of the probable occurrence of tornadoes, for it is necessary to radically change the system of predicting. It would seem wiser to determine as nearly as possible the central point of any probable disturbance, three hundred or four hundred miles to the south-east of a general storm, and then give boundaries more or less definite to the violence of the storms. This we are able to do from what is known of the behavior of such storms. In verifying, we should consider all the storms that occurred, and give weights corresponding to their distance from the centre of the disturbed region, and to their intensity.

Tornado Photographs.

One of the most recent developments in tornado studies has been a strong desire to photograph this extraordinary appearance. It is very unfortunate that this desire has become so strong that unscrupulous persons have resorted to photographing sketches of tornadoes, and selling them for the real article. It is also unfortunate that all these alleged photographs have been made at distances of from ten to twenty miles. It is a great desideratum that we have many photographs taken at much closer quarters, and this is not so impossible as might at first sight appear. It would be useless for any one to attempt a photograph on the south side of a tornado within a thousand or fifteen hundred feet; but on the north side we have repeated authentic observations of persons who stood within one hundred and fifty feet, and did not feel any violent wind. It is much to be hoped that a photographer will catch, by his instantaneous flash, one of these monsters as it passes just south of his position. It will require more than the usual amount of bravery to do this, however, as is very plain.

Alleged Photograph.

While nearly all these photographs show quite plainly their origin, yet there is a single exception in a picture representing an alleged tornado near Jamestown, Dak., on June 6, 1887, recently published in a prominent magazine. There is no doubt that this is a genuine photograph. There exist most serious difficulties in regarding it a tornado-cloud, however. The picture shows a dense mass of cloud extending from the trees at the earth up to the uniform veil of cloud above, with clear sky on either side. This mass has a thickening on the right-hand side, and this is supposed to be the tornado. The appearance is exactly that of a cloud-burst, as has been often witnessed, and not at all of a tornado. The dimensions of the camera and the distance of the cloud give the height between two and three miles. The distance of the cloud was variously estimated from eighteen to twenty miles. There was no destruction, and no one saw it, at the spot where the tornado was supposed to be. The only way it could be located was by following two lines of sight of persons from ten to fifteen miles away until they crossed. Drawings of a sand-whirl, not far from the alleged tornado, showed a funnel-cloud, and nothing at all like this indefinite mass in the picture. The evidence is quite conclusive that on this day there were in this region several appearances simulating cloud-bursts, tornadoes, and sand-whirls. It is very probable that this photograph was that of a cloud-burst within two or three miles of Jamestown. It is highly improbable that either a cloud-burst or a tornado ever had a height exceeding two or three thousand feet. A photograph of a funnel-cloud showing details, and especially two or three photographs taken as the cloud comes up and passes by, would be of the highest interest, and invaluable at this stage of our studies.

H. A. HAZEN.

NOTES AND NEWS.

THE Norwegian Storthing, by 73 votes against 39, has voted a grant of 200,000 kroner for Dr. Nansen's north pole expedition, says *Nature*.

—The third international shorthand congress will be held at Munich from Aug. 7 to 17, says *Nature*. The centenary of F. X. Gabelsberger, the originator of modern German shorthand, will be celebrated by those who attend the meetings, and a bronze statue of him will be unveiled.

—The Entomological Club of the American Association will meet at 9 A.M., on Wednesday, Aug. 20, in the room of Section F, State House, where members of the club will register and obtain the club badge. The president is Professor A. J. Cook, Agricultural College, Mich.; secretary, F. M. Webster, Lafayette, Ind. Members of the club intending to contribute papers will send titles to the secretary. The Botanical Club will hold a meeting, as usual, on Thursday, Aug. 21, at the State House. Communications should be sent to the president, Dr. N. L. Britton, Columbia College, New York, or to the secretary, Dr. Charles R. Barnes, University of Wisconsin, Madison, Wis. The Society for the Promotion of Agricultural Science will hold its eleventh annual meeting in Indianapolis, beginning on Monday evening, Aug. 18, in the room assigned to Section I in the State House, and continuing on Tuesday. For further information address Professor W. R. Lazenby, secretary, Ohio State University, Columbus, O. The

American Geological Society will hold its semi-annual meeting at the State House in Indianapolis on Aug. 19. Professor J. D. Dana, New Haven, Conn., is the president, and Professor J. J. Stevenson, University of the City of New York, secretary. Members of the association arriving in Indianapolis before the meeting should call for information at the temporary office of the local secretary, No. 19½ North Pennsylvania Street. A few days before the meeting a local office of information will be established near the railroad-station, as will be stated in the circular of the local committee.

— Professor Arthur Winslow, State geologist of Missouri, in submitting to Gov. Francis a statement setting forth the operations of the State Geological Survey during the month of June, says that during the early portion of the month the results of detailed field-work in the coal-fields were reduced, and transferred to the final map. Since this time field-work has been continued, and about twenty square miles have been covered. Paleontologic work has been continued in Pettis County, and has been extended into Lafayette County as far as Odessa. Several hundred pounds of specimens have been collected, and have been shipped to Professor Williams for study. On June 20 Mr. Erasmus Haworth reported for work, and has been assigned to the south-eastern part of the State, where he is engaged in defining the distribution and relations of the crystalline rocks of that section. Mr. Haworth is professor of geology and mineralogy at Penn College, Oskaloosa, Io. He has worked in the south-eastern portion of the State in past years, and has volunteered his services to the survey during the present summer. In the laboratory the analytical work on the mineral waters collected in April is completed, as well as the calculation of results, and the preparatory notes for a report on the results have been written out. In addition, analyses have been made of forty-seven specimens of limestone from quarries in and about St. Louis, with the object, among others, of determining their qualities for building-purposes, and for the production of lime and cement. Inspections have been made in Cape Girardeau and Stoddard Counties. In Cape Girardeau County clay deposits of promising appearance were visited. The qualities of the clay and the distribution of the deposits deserve determination. In Stoddard County a deposit of brown coal or lignite was visited, near Ardecla, on the Cotton Belt Railway. This coal has been opened up during the past winter by shafts and drifts. It occurs associated with the clays and sands of Crowley's Ridge. Similar coal is found along the same ridge farther south, in Arkansas.

—The latest plan for connecting a moving tram-car to an underground conductor without a slot in the roadway is that of the Lineff Electric Traction and Lighting Syndicate, of 11 Queen Victoria Street, London. According to *Engineering*, the track consists of the usual grooved rails, and a third or contact rail between the others. This is flat-topped, and the surface lies flush with the roadway. It is formed in short lengths, about three feet, separated from each other by about half an inch of asphalt. These short rails are electrically insulated from each other, and the current is directed into each of them in succession as the car passes over them. This, as is well understood, is to prevent the excessive leakage that would take place if a long length of rail were in connection with a wet roadway, and also to prevent other vehicles making a short circuit between the contact rail and the return-current rail. The connection of the short rails with the copper conductor is made by a magnet on the car acting on a contact-maker under the rail, one end of this contact-maker being joined to the conductor. On the under side of the car is a very powerful electro-magnet about one and a half times the length of a rail. At each end it has a pole-piece, consisting of a roller running on the rail, and two blocks just clearing the rail. This magnet is energized by the main current, and consumes one hundred and twenty to one hundred and fifty watts, although sixty are said to be sufficient for the purpose, under favorable circumstances. The rail, which is five or six inches deep, stands on a longitudinal earthenware sleeper; and the whole is solidly embedded in a mass of asphalt, which extends below the sleeper. In a groove in the sleeper runs the conductor, and in a second groove is laid a strip of galvanized hoop iron. This strip is connected at one end to the conductor, and the other end is free. When the magnet passes over it, the rail attracts the iron, which rises, and makes contact with it. The current then flows from the conductor through the strip to the rail, and thence by a bush to the motor on the car. Neither the strip nor the rail has any special contact surfaces. They are both galvanized, and there is no other means provided to insure good connection. As soon as the magnet has passed, the rail ceases to be magnetic, the strip falls back, and that particular rail is again insulated, its office being taken by the one in front of it; and so on. The principal feature of novelty lies in the use of a second, or so-called "hidden rail," placed alongside the contact rail underground, and, like it, embedded in the asphalt. This is also in short lengths, but it is disposed so as to break joint with the first rail, and thus reduce the resistance of the magnetic circuit. It is stated that by the use of this second rail a very much less powerful magnet is able to move the contacts. The inventor seems to have aimed at cheapness of construction; and it is feared that difficulties will arise in practice from the crudeness of some of his arrangements, although a short experimental line in the yard of the West Metropolitan Tramway Company, Chiswick High-Road, works very well.

—Miss C. W. Bruce offers the sum of six thousand dollars during the present year in aiding astronomical research. No restriction will be made likely to limit the usefulness of this gift. In the hope of making it of the greatest benefit to science, the entire sum will be divided, and in general the amount devoted to a single object will not exceed five hundred dollars. Precedence will be given to institutions and individuals whose work is already known through their publications, also to those cases which cannot otherwise be provided for, or where additional sums can be secured if a part of the cost is furnished. Applications are invited from astronomers of all countries, and should be made to Professor Edward C. Pickering, Harvard College Observatory, Cambridge, Mass., before Oct. 1, 1890, giving complete information regarding the desired objects. Applications not acted on favorably will be regarded as confidential. The unrestricted character of this gift should insure many important results to science, if judiciously expended. In that case it is hoped that others will be encouraged to follow this example, and that eventually it may lead to securing the needed means for any astronomer who could so use it as to make a real advance in astronomical science.

—The increasing importation of foreign meat to England has resulted in the invention of a number of refrigerating appliances, among them Hill's patent system of dry-air refrigerating apparatus, which is on view at the working dairy at the Royal Military Exhibition, Chelsea, Eng., and at the offices of the company, 114 Cannon Street, London. The distinctive feature is that no machinery is in use, the cold air being produced from the distillation of ammonia gas, a principle which is not by any means new. The apparatus consists of steam-generator, ammonia boiler, separator, and condenser for producing cold, and a refrigerator or cold chamber. This chamber, as described in *Engineering*, is constructed in most cases of a double casing of wood, lined with charcoal as a non-conductor; and the roof is formed by a tank containing a bath of chloride of calcium liquor in sufficient quantity to store up the cold as produced. In the case of the apparatus exhibited on Cannon Street on Wednesday, June 25, the chamber was seven feet by nine feet by seven feet high, and the ammonia boiler two feet diameter by ten feet long. The solution of ammonia in the boiler is heated by steam from any boiler, or from a specially constructed slow-combustion stove, with a spiral coil giving large heating surface. Alongside it is placed a water separator for drying the steam, which passes to a boiler three-fourths filled with a solution of ammonia. To this the steam entering by several pipes imparts heat, driving the ammonia into the form of gas. Above the boiler is placed a separator for taking off water carried forward in the distillation of the ammoniacal gas. The water thus separated passes by gravitation to the boiler. Alongside it is a corresponding cylindrical vessel into which the dried ammoniacal gas passes, and there it is condensed by its own accumulation of pressure, and the latent heat carried off by the

circulation of cooling water. This liquid anhydrous ammonia flows into the refrigerators suspended in the tank forming the roof of the cooling-chamber. The pressure is then rapidly reduced by opening a communication with a separate chamber, and the sudden evaporation of the liquid anhydrous ammonia takes place at the expense of the sensible heat in the cold-storage bath in the tank, which therefore becomes very cold, and draws heat from the chamber in which the meat is stored. The bottom of the tank is corrugated, which gives a large increase in the cooling area; and to the lower angles of the corrugation, gutters are suspended, carrying off the water, so that the atmosphere is dried as well as cooled. On June 25, the temperature, after the doors of the chamber were closed, was reduced in a comparatively short time by about 40° to 39°. It was tested from the evening of June 14 to the morning of the 20th, and it is said that the temperature of the liquid in the tank rose in that time from 16½° to 31°; the fall of temperature in the chamber being from 52° to 36¼°, while in the office in which the chamber was placed the fall was from 65° to 61°.

—Among the papers read at the closing meeting of the Royal Society, London, was one by Professor Ewing of the Dundee College, entitled "Contributions to the Molecular Theory of Induced Magnetism," in which experiments of a novel and curious kind were described, leading to an important conclusion. Professor Ewing has examined experimentally Weber's theory of molecular magnets, according to which the molecules of iron are always magnets, which point anyhow in an unmagnetized piece, but are turned round to point one way when the iron is magnetized. It is well known that in the development of this theory by Maxwell and others there has been much difficulty in reconciling the results of the theory with what is known about the magnetic quality of iron and steel, and many arbitrary assumptions have been suggested in order to make the theory fit the facts. Professor Ewing's experiments have removed this difficulty, showing that no arbitrary assumptions are necessary, and that the known character of the magnetizing process may be deduced from the molecular theory in its simplest form. The experiments, as described in *Nature*, were made by means of a model in which a large number of small pivoted permanent magnets are grouped to represent the molecular structure of iron. When a magnetic field is applied, the action of the small magnets on one another makes them behave in a way that exactly agrees with the observed behavior of a bar of solid iron when it is magnetized. The model exhibits all the variations of susceptibility which are known to take place, and explains how magnetic hysteresis occurs without any thing like friction among the molecules.

—An exceptionally pretty and instructive series of new experiments upon the action of carbon heated to whiteness in the electric arc on various gaseous compounds is described in a late number of the *Berichte* by Professor Lepsius of Frankfurt, according to *Nature* of July 3. Perhaps the most important are a group of four experiments illustrating the relative combining powers of the four elements, iodine, sulphur, phosphorus, and carbon. The apparatus employed consists of a specially modified Hofmann eudiometer, one limb of which is 40 millimetres in diameter and 300 millimetres long, and the other longer limb narrower, and furnished with a mercury reservoir at its upper end. The wider limb, which is the re-action tube, is furnished with a stop-cock at the top, and just below this are two tubuli through which the adjustable carbon poles are inserted. At the base of the wider limb a second stop-cock is placed so as to permit of the adjustment of the mercury. The gas to be experimented upon is introduced into the apparatus at the upper stop-cock by allowing mercury to run out at the base. Four such eudiometers are arranged in a row, and 100 cubic centimetres of gas introduced into each. Into the first, hydriodic acid is introduced; into the second, sulphuretted hydrogen; into the third, phosphuretted hydrogen; and into the fourth, marsh-gas. The gases thus stand at the same level in each of the four re-action tubes. The current from a battery whose electro-motive force should amount to 60 to 80 volts is then allowed to pass between the carbon poles, which are, of course, in contact at first, and then gradually drawn away until the maximum arc is obtained. Each re-action may be performed separately, or all four may be allowed to proceed simultaneously by adopting an arrangement in multiple arc. In hydriodic acid the brilliant arc-light is tinted a magnificent purple, and the whole space above the mercury becomes filled with violet vapor of iodine. Notwithstanding the considerable heating effect of the discharge, the volume of gas perceptibly diminishes, the liberated iodine rapidly depositing in minute crystals upon the walls of the tube. So rapid, indeed, is the diminution in volume, that mercury requires to be poured into the reservoir to prevent the entrance of air into the re-action tube. In a very few minutes the re-action is complete, and the mercury ceases to rise. In sulphuretted hydrogen the light is colored blue, and copious clouds of suphur are produced, which settle upon the walls in the form of a white transparent coating. The volume of gas is considerably augmented, owing to the expansion by heat, and the re-action is likewise completed in a very brief space of time. In phosphuretted hydrogen the arc glows with a dazzling red light, the volume visibly augments at a rapid rate, and red clouds of phosphorus are thrown off, the glass walls being covered with red phosphorus, among which are to be found notable quantities of the ordinary yellow variety. The mercury attains its maximum height in the narrow limb in a minute, at most, from the moment of switching on the current. In the case of marsh-gas, the whiteness of the arc appears at first to be rendered more intense, and is surrounded by dense black clouds of carbon, which form a striking background. The upper part of the vessel, however, soon becomes covered with an opaque deposit which perceptibly diminishes the brilliancy of the light. The volume appears to increase by leaps and bounds, and in a few seconds attains its maximum. At the end of the experiment, after cooling, the volume of hydrogen left in the first case is 50 cubic centimetres; in the second, 100; in the third, 150; and in the fourth case, 200; thus showing in a most striking manner that an atom of iodine combines with one atom of hydrogen, sulphur with two, phosphorus with three, and carbon with four, atoms of hydrogen.

—According to *Nature* of July 3, the third summer meeting of university extension and other students will be held at Oxford in August next. The meeting will be divided into two parts. The first part of the meeting will begin with an inaugural address by Professor Max Müller at 8.30 P.M. on Friday, Aug. 1, and will end on Tuesday evening, Aug. 12. The second part of the meeting will begin on Wednesday morning, Aug. 13, and end on Tuesday evening, Sept. 2. This period will be devoted to quiet study. The courses of lectures will be longer than those delivered during the first part of the meeting, and will deal in greater detail with the subjects then introduced.

—The clove-tree was introduced into Zanzibar about the year 1830, and its cultivation now forms the chief industry of the islands of Zanzibar and Pemba. The chief supply of cloves is obtained from these islands. Consul Pratt, who has lately written a report on the clove-culture of Zanzibar, says that a ten-year-old plantation should produce an average of twenty pounds of cloves to a tree. Trees of twenty years frequently produce upwards of one hundred pounds each. Mr. Pratt reports that the yield of the present season will probably exceed that of any previous season, and amount to thirteen million pounds, averaging a local value of ten cents per pound.

—A pneumatic dynamite gun built for the British Government was tested at Cold Spring, N.Y., on July 8, in the presence of several military and naval officers. As the test was merely to determine the range and capabilities of the gun, and not the destructiveness of the projectiles, the latter were filled with sand instead of an explosive. Four shots were fired, two of which were failures, the thin brass shells of the projectiles bursting in mid-air, owing perhaps to defective packing of the sand. The other shots were successful; the projectiles, weighing 520 pounds each, attaining a range of 4,008 and 4,680 yards respectively, the contract only requiring a range of 3,500 yards. The gun, or shooting-engine as it may be called, is fifty feet long, and weighs much less than four tons. It is a modification of those with which the dynamite cruiser "Vesuvius" is armed.